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ABSTRACT

This booklet is intended to help mainstreamed mentally retarded, emotionally disturbed, or learning disabled high school students acquire a basic understanding of the responsibilities and working conditions of combination welders and to practice basic math skills necessary in the occupation. The first section provides a brief introduction to the occupation by focusing upon those job tasks of a combination welder with which the student is likely to be familiar. The next two sections deal with the work environment of the typical combination welder and the training, education, and experience needed for the occupation. Exercises addressing basic math skills used by combination welders are provided. Various suggestions are listed for students interested in further exploring the occupation of combination welder. A glossary and answer sheet conclude the booklet. (KC)

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MATH on the job

Combination Welder

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MATH ON THE JOB:

COMBINATION WELDER

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MATH on the job

Combination Welder

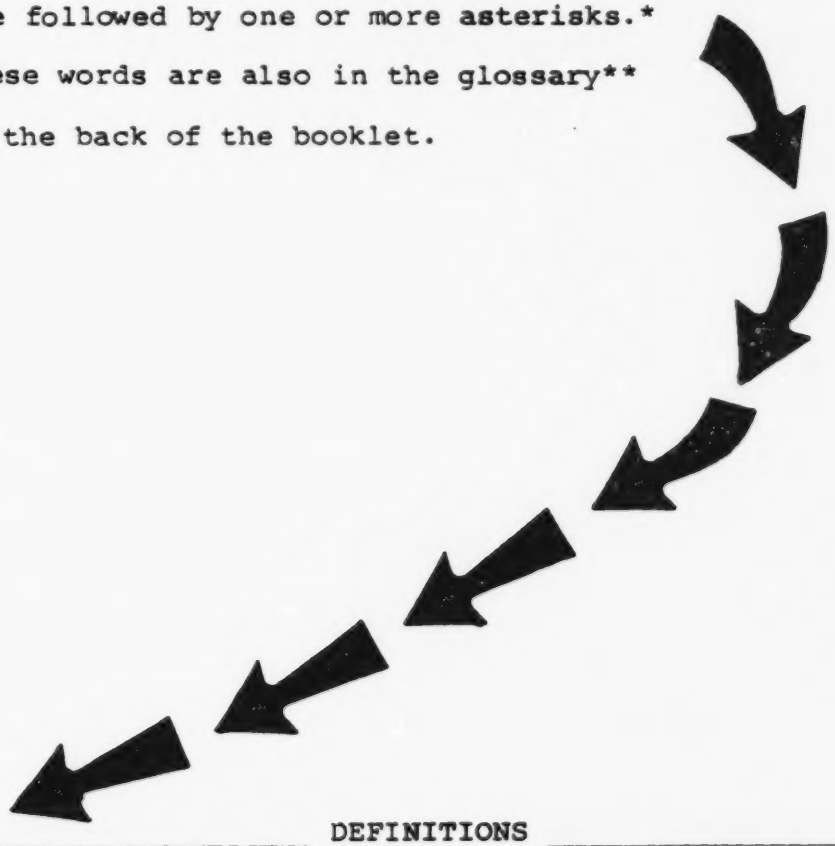
In this booklet, you can--

- find out what a combination welder does
- see how a combination welder uses math
- get a chance to use math as a combination welder
- find out the types of things a combination welder needs to know
- find out what courses, training, and experience you need to become a combination welder

SPECIAL WORDS USED IN THIS BOOKLET

Workers in many jobs use special words or special meanings for words. Learning these words helps you to learn about a job.

You will find some of these special words in this booklet. When these words, and some hard words, are used for the first time, they are followed by one or more asterisks.* These words are also in the glossary** at the back of the booklet.



DEFINITIONS

*An asterisk (*) is a symbol that tells you to look at the bottom of the page for the meaning, or definition, of the word.

**A glossary is a list of words with their meanings.

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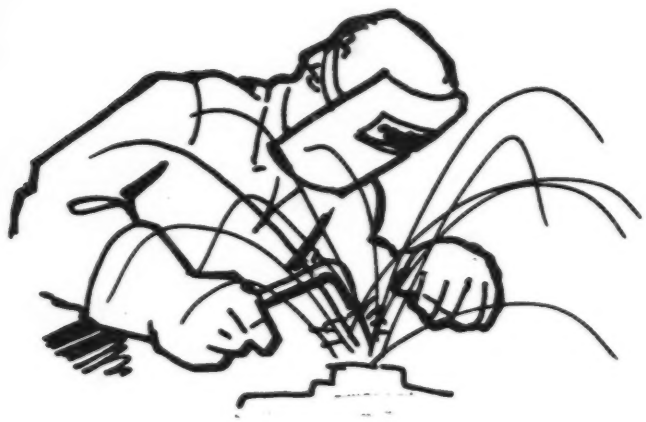
HAVE YOU EVER...

- watched a person repair a broken bicycle frame by heating it with a gas torch?
- **soldered*** wires together?
- watched a welder cut metal with a welding torch and seen sparks fly?
- had to have a leaking automobile radiator repaired?
- watched a welder use a welding torch to heat and join metal beams while constructing a building?
- used a grinder to smooth or shape a piece of metal?

If you have, then you have some idea about the work of a combination welder. This booklet will help you learn about the work of a combination welder and how math is important to do the job.



DEFINITION

*To **solder** means to heat metal surfaces and a soft metal alloy (combination) of tin and lead to cause the alloy to melt and join the metal surfaces.

WHAT DOES A COMBINATION WELDER DO?

As a combination welder, you join together (weld) metal parts or pieces. A combination welder constructs or repairs objects or things. Examples of things that are welded include machine parts, construction equipment, electric motors, and automotive parts. As a combination welder, you--

- read and use charts, **blueprints***, and work orders.
- prepare materials that are to be welded by removing paint, oil, dirt, or rust. A clean metal surface will weld more easily.
- weld (join or unite) metal parts by heating them to a temperature that causes them to melt and **fuse**** together.
- cut metal by heating it to a temperature that causes the metal to melt and separate into parts.
- use a chipper or wire brush to clean materials after the weld is completed.
- work with different kinds of metals such as steel, aluminum, and copper.
- know how and when to use each welding method.

DEFINITIONS

*Blueprints are drawings that show how something is to be built or put together.

**To fuse means to blend or melt together.

A combination welder uses math on the job every day.

As a combination welder, you--

- add, subtract, multiply, and divide
- make calculations with whole numbers, decimals and fractions
- change fractions to decimals
- take measurements
- read diagrams and blueprints
- use the **metric system***
- prepare and set up materials to be welded using dimensions from blueprints
- measure the thickness of material to be welded
- measure and select correct welding tip sizes
- set and read gas pressure gauges
- set and read dials and gauges on electric welding machines
- guess carefully the cost for performing welding work
- prepare customer bills for the work performed

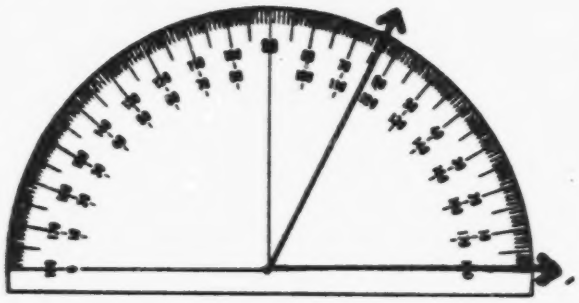
DEFINITION

*Metric system is a decimal system of weights and measures which uses the base 10. An example is the U.S. system of money since 10 pennies = 1 dime; 10 dimes = 1 dollar; 10 dollars = a ten-dollar bill; etc.

A combination welder uses math to measure angles.

EXAMPLE

Many different units are used to express the measure of an angle. One of the most common units is the degree which is designated by the symbol ^{o}. A protractor is an instrument marked in degrees and is used to measure angles. A picture of a protractor is shown below.



To find the measure of an angle using a protractor, follow these steps:

Step 1. Place the protractor so that the center mark at the bottom of the protractor is where the two sides of the angle meet. The 0^{o} mark on the protractor should be on one side of the angle.

Step 2. Read the mark on the protractor that is on the far side of the angle, away from the 0^{o} mark.

a. If the far side of the angle extends to the right of where the two sides meet, read the outer scale on the protractor.

b. If the far side of the angle extends to the left of where the two sides meet, read the inner scale of the protractor.

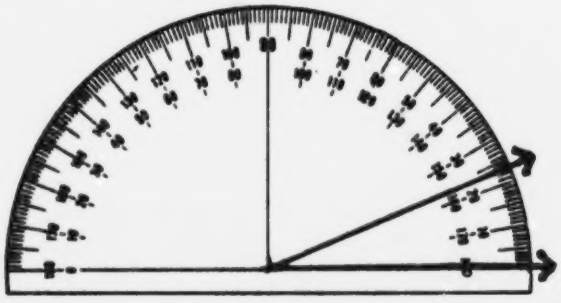
What is the measure of the angle shown above? You're right if you said 64^{o}.

NOW YOU TRY IT

Practice Exercise A

What is the measure of each angle below?

1.



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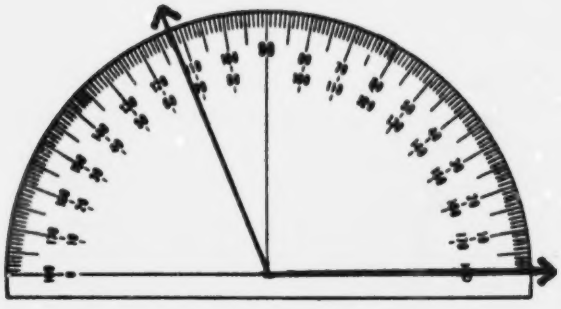

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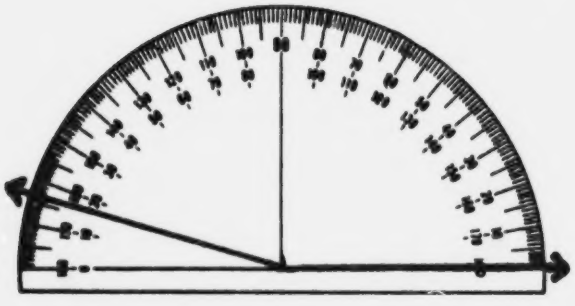
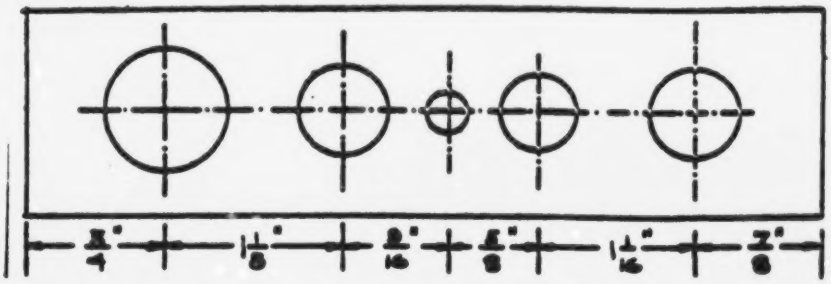


A combination welder uses math to figure out the dimensions on drawings.

EXAMPLE

Let's assume that you are welding a metal part for a boat. A sketch of the part appears below.



What is the total length in inches of the part? To find the total length, add each separate measurement. To add measurements with fractions, follow these steps:

Step 1. Find the common denominator. In this example, the common denominator is 16.

Step 2. Convert the fractions to the common denominator. In this example, you will convert

3/4" to 12/16"
1-1/8" to 18/16"
9/16" to 9/16"
5/8" to 10/16"
1-1/16" to 17/16"
7/8" to 14/16"

Step 3. Add the fractions. For this example, the sum of the fractions is 80/16".

Step 4. Simplify the answer to its lowest form. In this example, the answer is 5".

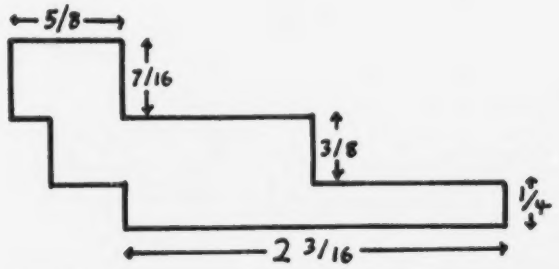
The total length of the part is 5 inches.

Practice Exercise B

Find the dimensions of the metal parts in the drawings below. All measurements are given in inches.

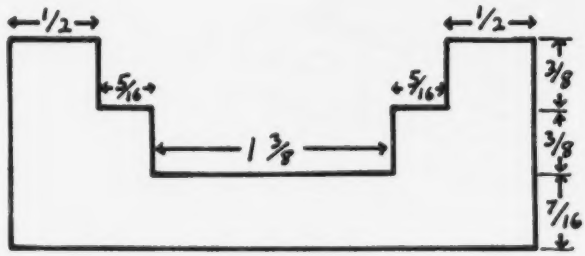
4. Find the total length of the drawing below.

5. Find the total width of the drawing below.



6. Find the total length of the drawing below.

7. Find the total width of the drawing below.

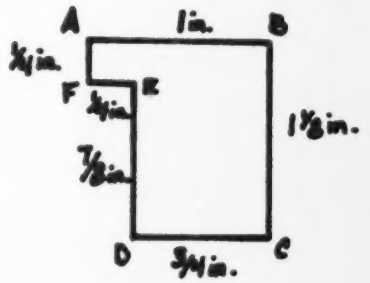


A combination welder uses math to make drawings and sketches of parts.

EXAMPLE

As a combination welder, you may want to make a scale drawing of a part like the one below. For this example, let's assume that each length in your scale drawing will be 1/2 as long as the actual length. To find the scale measurements, multiply the actual measurements by 1/2.

AB = 1 in. x 1/2 = 1/2 in.
BC = 1-1/8 in. x 1/2 = 9/16 in.
CD = 3/4 in. x 1/2 = 3/8 in.
DE = 7/8 in. x 1/2 = 7/16 in.
EF = 1/4 in. x 1/2 = 1/8 in.
FA = 1/4 in. x 1/2 = 1/8 in.



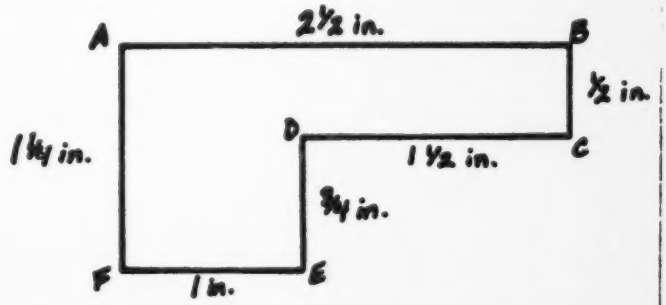
NOW YOU TRY IT

Practice Exercise C

In the scale drawing for this part, each length will be 1/4 as long as the actual length. Find the scale measurements for each length listed. The first problem is done for you.

AB = 5/2 in. x 1/4 = 5/8 in.

8. BC
9. CD
10. DE
11. EF
12. FA



A combination welder uses math to reduce the amount of material that will be wasted.

EXAMPLE

As a combination welder, it is important that you plan your work. You will plan your work so that you use materials wisely. Assume that you have a piece of metal 12-1/2" long. How many 5/16" pieces can you cut from the piece of metal?

Step 1. Find the lowest common denominator. In this example, the common denominator is 16.

Step 2. Convert the fractions to the common denominator. In this example, convert 12-1/2" to 200/16".

Step 3. Divide the length of the piece of metal by the size of the piece you cut:

$$200/16 \div 5/16 = 40$$

You can cut 40 pieces.

NOW YOU TRY IT

Practice Exercise D

13. A piece of metal is 24-3/4" long. How many 9/16" pieces can you cut from the piece of metal?

14. A piece of metal is 18-1/2" long. How many 3/4" pieces can you cut from the piece of metal?

15. How many 1-1/4" pieces can you cut from a piece of metal 34-5/8" long?

16. How many 2-1/2" pieces can you cut from a piece of metal 16-3/8" long?

WHERE DOES A COMBINATION WELDER WORK?

A combination welder works in many different places welding and cutting metal parts. As a combination welder, you may work in a--

- factory
- shipyard
- welding shop
- machine shop
- automobile body repair shop

A combination welder also works on construction jobs helping to build--

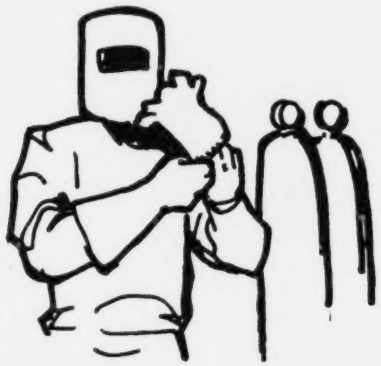
- bridges
- dams
- buildings
- pipe lines

You will work with other skilled workers as a team to make sure the work is done properly. Some other people you will work with are--

- weld inspectors who inspect and test welded joints and mark mistakes
- welder helpers who assist skilled welders to set up the work to be performed, maintain equipment, and clean and organize the work area
- welding supervisors who give directions to other welders

A welder uses many different tools and types of welding equipment. You might use--

- welding torches to mix and control gases.
- spark lighters to make sparks that set gases on fire.
- regulators or valves to control the flow of gases.
- filler rods to strengthen the weld. Filler rods are slender metal rods that are melted and added to the weld during the welding process.
- fluxes to clean the metal being welded.
- welding machines to make welds electrically.
- wire brushes to clean parts and equipment after they are welded.
- chipping hammers to remove **slag*** from metal that has been welded.
- electrodes to conduct electricity. These are used in electric welding.
- clamps to hold metal parts together or in place during the welding process.
- safety equipment to protect the worker such as goggles, helmets, gloves, and heavy work aprons.



DEFINITION

*Slag is the useless material that results from the melting of metals.

There are many types of welders. Some of the types are--

- shipyard welders who join the plates, beams, and pipes used to build a ship.
- maintenance welders who repair tools, machines, and equipment.
- welding machine operators who place parts to be welded in a welding machine. They operate the machine, and remove the parts after the weld is complete.
- cutters who cut and trim metal by using heat from burning gases or an electric arc.

IF YOU ARE INTERESTED IN

THE WORK OF A COMBINATION WELDER

AND WOULD LIKE TO KNOW MORE,

READ ON

WHAT TRAINING, EDUCATION, AND EXPERIENCE DO YOU NEED TO BECOME A COMBINATION WELDER?

A combination welder is a highly skilled worker. You must know--

- how to identify metals
- the features of different metals
- the welding methods that are required for use with different metals

A welder also needs to know how to--

- use **safety procedures*** to protect self and others
- perform work quickly and at the same time do good work
- guess carefully the cost of repairs or construction of new equipment
- recognize **symbols**** used in welding

DEFINITIONS

*Safety procedures are what is done or used to protect persons or property from injuries or losses (e.g., special clothing or glasses, gloves, work shoes, not welding near an oxygen tank).

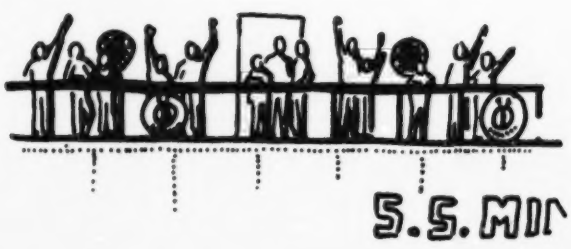
**Symbols are marks which stand for something. ↘ is the mark or reference line and arrow used in welding diagrams to point at the joint to be welded.

The best way to learn these skills is to begin taking welding, math, blueprint reading, and drafting courses in high school. These courses will prepare you for more education and training at a vocational center or technical college.

You may also learn to be a combination welder by completing high school and then entering an apprenticeship program. In these programs, you work and study on the job and are taught welding skills by experienced combination welders. Apprenticeship programs may take up to four years to complete. Apprentices are paid for the work they perform during training.

Welder training is also provided by private schools, companies that use welders in their manufacturing process, and the military services. This training may last from six months to a year.

After getting a job as a combination welder, you can move up to more responsible, higher paying jobs by learning more skilled welding methods. Some welders go on to college and become welding engineers. Good math skills will help you prepare for a beginning job as a combination welder. They will also help you advance to more skilled welding positions.

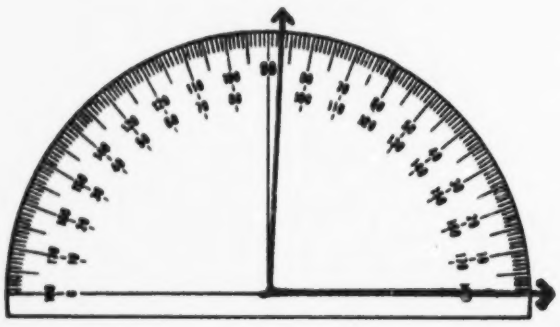


DO YOU WANT TO DO MORE COMBINATION WELDER'S MATH?

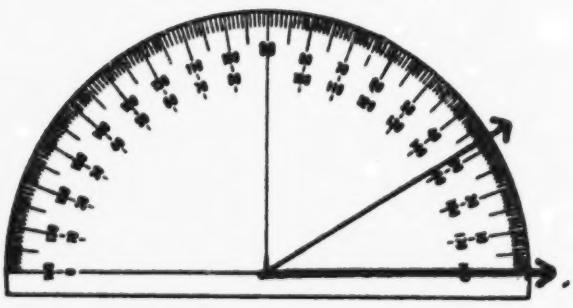
Practice Exercise E

What is the measure of each angle below?

17.



18.



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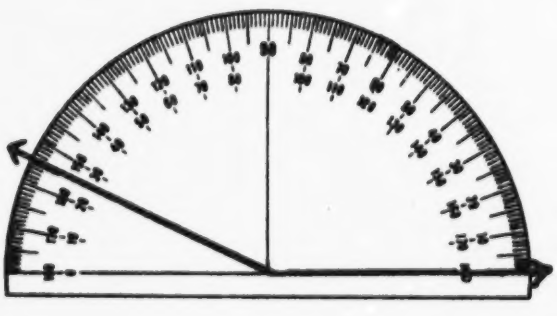
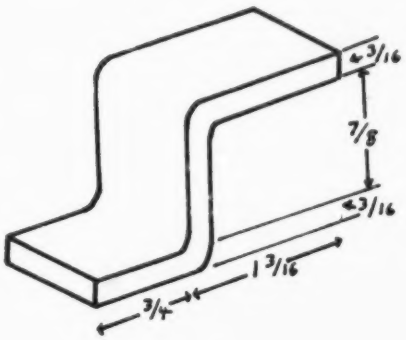


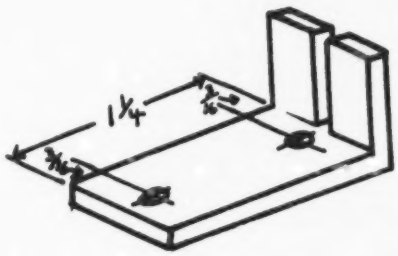
Practice Exercise F

Find the dimensions in the drawings below. All measures are given in inches.

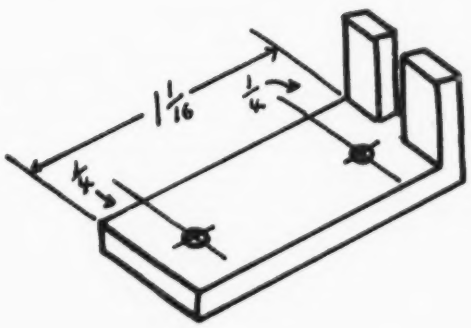
20. Find the total length.
21. Find the total height.



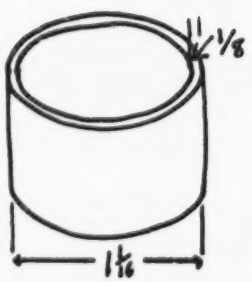
22. Find the distance between the centers of the holes.



23. Find the distance between the centers of the holes.



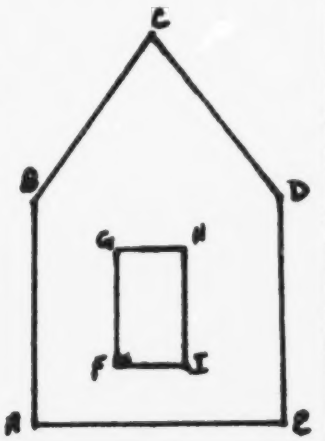
24. Find the inside diameter.



Practice Exercise G

In the scale drawing for the part below, each length will be 3/8 as long as the actual length. For the practice exercise, measure the length of each side to the nearest 1/8 inch. Then multiply the actual length by 3/8 to find each measure for the scale drawing. The first problem is done for you.

Side	Actual Length	Length in Scale Drawing
AB	1-1/4 in.	15/32 in.
25. BC		
26. EA		
27. FG		
28. GH		



Practice Exercise H

29. A piece of metal is 8-1/2" long. How many 1/4" pieces can you cut from the piece of metal?

30. A piece of metal is 25-7/8" long. How many 5/16" pieces can you cut from the piece of metal?

31. A piece of metal is 4 ft. 3 in. long. How many 1-1/2" pieces can you cut from the piece of metal?

32. How many 8-1/2" pieces can you cut from a piece of metal 3 ft. 6 in. long?

33. How many 10" pieces can you cut from a piece of metal 5 ft. 3 in. long?

DO YOU WANT TO EXPLORE SOME MORE?

1. If your school offers welding courses, arrange a visit to the welding shop. Talk with the instructor and students. Find out what types of welding are taught, the courses that would help you as a welder, and why students are taking welding.

2. Visit a welding shop in your community. Observe welders performing their work. Talk to a welder. Ask what the welder likes and dislikes about welding.

3. Visit a factory in your community that uses the welding process to manufacture articles. Compare the welding done in the factory to the welding done in a welding shop. Are they the same or different? Where would you prefer to work?

4. Visit the local state employment service office. Talk with an employment counselor. Find out what the need for welders is in your community. What will be the future demand for welders? Will there be an increase or decrease in the need for welders?

5. Welding can be dangerous work. Welding produces heat, smoke, and fumes. Electrical welding equipment such as generators produce dangerous levels of electrical current. Gases used in welding will burn easily and are explosive. Do you think you would be bothered by these safety hazards? Do you think you would practice all the necessary safety precautions?

6. Welders must clean the material to be welded before and after welding. This means you will be cleaning up such things as oil, grease, dirt, paint, and rust. Welding is not the type of job that allows you to remain clean and neat all the time. Do you think you would like to do this type of work? Why or why not?

GLOSSARY

Asterisk (*): a mark that tells you to look at the bottom of the page for the meaning, or definition, of the word.

Blueprints: drawings that show how something is to be built or put together.

Fuse: to blend or melt together.

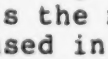
Glossary: a list of words with their meanings.

Metric system: a decimal system of weights and measures which uses the base 10 in all the scales. An example is the U.S. system of money as 10 pennies = 1 dime; 10 dimes = 1 dollar; 10 dollars = a ten-dollar bill; etc.

Safety procedures: what is done or used to protect persons or property from injury or loss (e.g., special clothing or glasses, gloves, work shoes, not welding near an oxygen tank).

Slag: the useless material that results from the melting of metals.

Solder: to heat and melt a soft alloy (combination) of tin and lead to join metal surfaces.

Symbols: marks or signs which stand for something.  is the mark or reference line and arrow used in welding diagrams to point at the joint to be welded.

ANSWER SHEET

Practice Exercise A

1. 23°
2. 112°
3. 163°

Practice Exercise B

4. 2 13/16"
5. 1 1/16"
6. 3"
7. 3"

Practice Exercise C

8. 1/8 in.
9. 3/8 in.
10. 3/16 in.
11. 1/4 in.
12. 5/16 in.

Practice Exercise D

13. 44
14. 24
15. 27
16. 6

Practice Exercise E

17. 87°
18. 23°
19. 154°

Practice Exercise F

20. 19/16
21. 1 1/4
22. 7/8
23. 9/16
24. 13/16

Practice Exercise G

25. 1-1/8 in.; 27/64 in.
26. 1-3/8 in.; 33/64 in.
27. 5/8 in.; 15/64
28. 3/8 in.; 3/32

Practice Exercise H

29. 34
30. 82
31. 34
32. 4
33. 6